Forces and Motion

PS-5 The student will demonstrate an understanding of the nature of forces and motion.

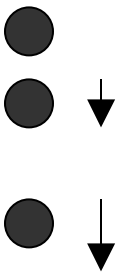
PS-5.5 Explain how acceleration due to gravity affects the velocity of an object as it falls.
Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Key Concepts:
Acceleration due to gravity: a_g

Previous/Future knowledge: In 8th grade, students were introduced to gravity as a force and the effect that gravitational force has on the speed of objects as they analyzed the effects of gravity and friction on the speed and direction of an object (8-5.3). In Physical Science (PS-5.7) students will address the relationship between force and acceleration in more detail. The major emphasis of this indicator (PS-5.5) is the behavior of objects as they accelerate during free fall, not the reason that they accelerate.

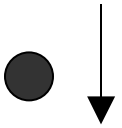
It is essential for students to understand that

- All objects accelerate as they fall because Earth continually exerts a force (gravitational force) on them.



The diagram depicts the position of an object freefall at regular time intervals. The fact that the distance which the ball travels every interval of time is increasing is a sure sign that the ball is speeding up as it falls downward. If an object travels downward and speeds up, then it accelerates downward.

- When an object is released it accelerates.
- The direction of the gravitational force is always downward.
- The acceleration is in the direction of the force, so the direction of the acceleration is downward as well.



- When an object is dropped from rest, it has an initial velocity of 0.0 m/s.
- The object will accelerate at a constant rate of 9.8m/s^2 or m/s/s.
  - This means that the object will speed up at a constant rate of 9.8 m/sec every second it is falling in the absence of air resistance.
- The value, 9.8m/s per s, is called the *acceleration of gravity* and has the symbol a_g.
- Since the object is accelerating because of the gravitational force that is attracting Earth and the object, the velocity of the object continues to increase in speed and continues to fall in a downward direction until it hits the ground.

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Students must understand the meaning of the values on the chart in terms changing velocity.

	v_i	v_f
1st s	0.0 m/s	9.8 m/s
2nd s	9.8 m/s	19.6 m/s
3rd s	19.6 m/s	29.4 m/s
4th s	29.4 m/s	39.2 m/s
5th s	39.2 m/s	49.0 m/s

Teacher note: Students may use 10 m/s/s for acceleration due to gravity for ease of calculation. Both 10 or 9.8 may be used on the end-of-course examination.

It is not essential for students to

- Consider the motion of free-falling objects influenced by other forces, such as
  - Air resistance,
  - Exerted forces such as rocket boosters;
- Consider the motion of objects which have been projected upward;
- Consider projectile motion other than straight down;
- Calculate values such as distance fallen, elapsed time, final velocity, or other values.

Assessment Guidelines:

The objective of this indicator is to *explain* how acceleration due to gravity affects the velocity of an object as it falls, therefore, the primary focus of assessment should be to construct a cause and effect model showing how acceleration due to gravity affects the velocity and displacement of an object in freefall.

For general assessment purposes acceleration due to gravity may be given as 10 m/s/s (10 m/s^2).

In addition to *explain*, assessments may require that students:

- *Illustrate* in words, pictures, or diagrams how velocity and displacement change as an object falls;
- *Summarize* how velocity and displacement change as an object falls;
- *Interpret* diagrams of objects in freefall.